````
---
title: "R Notebook"
output:
  pdf_document: default
  html_notebook: default
---

```{r}
#Ex1
ex1<-read.table("paper.txt", sep="\t", dec=".", header=TRUE)
attach(ex1)


```
```{r}

#define model

ex1.model.1 <- lm(strength~hardwood, data = ex1)
summary(ex1.model.1)

ex1.model.main <- lm(strength~hardwood + pressure, data = ex1)
summary(ex1.model.main)

#a
# Maximum likelihood estimation for beta2
coef(ex1.model.main)[3]

```
```{r}
#b
summary(ex1.model.main)$sigma^2
```

```{r}
#c
fitted(ex1.model.main)[1]
```

```{r}
#d
new.data<-data.frame(hardwood=c(7), pressure=c(550))
mu.hat<-predict(ex1.model.main, newdata=new.data, interval="confidence",
level=0.95)
mu.hat[1] # maximum likelihood point estimate
mu.hat[2] # lower bound of the 95% confidence interval
mu.hat[3] # upper bound of the 95% confidence interval

```
```{r}
#e
new.data<-data.frame(hardwood=c(7), pressure=c(550))
y.hat<-predict(ex1.model.main, newdata=new.data, interval="confidence",
level=0.80)

y.hat[1] # best linear unbiased point prediction
y.hat[2] # lower bound of the 80% prediction interval
y.hat[3] # upper bound of the 80% prediction interval
````
````

```
```{r}
#f
anova(ex1.model.1,ex1.model.main, test="F")
anova(ex1.model.1,ex1.model.main, test="F")$"F"[2] # the value of the
test statistic
anova(ex1.model.1,ex1.model.main, test="F")$"Pr(>F)"[2]  # p-value
```

```{r}
#ex2
ex2<-read.table("makiwaraboard.txt", sep="\t", dec=".", header=TRUE)
attach(ex2)
```

```{r}
#define models
ex2.model.main <- lm(Deflection~factor(WoodType) + factor(BoardType),
data = ex2)
summary(ex2.model.main)

ex2.model.12 <- lm(Deflection~factor(WoodType)*factor(BoardType), data =
ex2)
summary(ex2.model.12)

```
```{r}
#a
mu.42 <- predict(ex2.model.12, newdata=data.frame(WoodType="Oak",
BoardType="Tapered"))
mu.42
```
```{r}
#b
interaction.plot(WoodType,BoardType, fitted(ex2.model.main))

# From the plot, we see that "Cheery" WoodType gives the highest
estimated level of u
```
```{r}
#c
betahat<-coef(ex2.model.12)
#define K
k1<-c(0,0,0,0,0,1,0,0)
k2<-c(0,0,0,0,0,0,1,0)
k3<-c(0,0,0,0,0,0,0,1)

K<-cbind(k1,k2,k3)
#anova(ex2.model.main,ex2.model.12, test = "F")

q<-3
Wald<-(t(t(K)%*%betahat)%*%solve(t(K)%*%vcov(ex2.model.12)%*%K)%*%t(K)
%*%betahat)/q
Wald
p.value<-pf(Wald, 3, 328, lower.tail = FALSE)
p.value
```
```

```{r}
#d
pred<-predict(ex2.model.12,
newdata=data.frame(WoodType=c("Oak","Cherry"),
BoardType=c("Tapered","Stacked")))
pred[1]-pred[2]
```

```{r}
#e
betahat<-cbind(coef(ex2.model.12))
y1<-cbind(c(1,1,0,0,0,0,0,0)) ### Cherry =1, Stacked = 1
y2<-cbind(c(1,0,0,1,1,0,0,1)) ## Oak = 4, Tapered = 2

pred<-(t(y2)-t(y1))%*%betahat
sigma2<-sigma(ex2.model.12)^2

#construct the 80% interval
lower<-pred-qt(0.8,df=328)*sqrt(sigma2*(2+(t(y2)-t(y1))
%*%solve(vcov(ex2.model.12))%*%(y2-y1)))
upper<-pred+qt(0.8,df=328)*sqrt(sigma2*(2+(t(y2)-t(y1))
%*%solve(vcov(ex2.model.12))%*%(y2-y1)))

lower
upper
```